A HAPLOLEPID FISH FAUNA IN THE EARLY PENNSYLVANIAN OF NOVA SCOTIA

by DONALD BAIRD

ABSTRACT. A skull roof of the palaeoniscoid fish *Haplolepis* (*Parahaplolepis*) aff. *anglica* from the Lower Pennsylvanian near Parrsboro, Nova Scotia, provides the earliest record of the Haplolepidae and the first from Canada. The subgenus ranges from middle Westphalian A to late Westphalian D. A small *Gyracanthus* spine confirms the survival of this acanthodian genus into Pennsylvanian time in North America. The associated fauna includes palaeoniscoids, crossopterygians, and fresh-water arthropods.

Conflicting citations of haplolepid type specimens from Linton, Ohio, are pointed out, and overlooked but prior designations are noted.

THE abundance of Carboniferous fish material at scores of localities along the shores of Nova Scotia would hardly be guessed from a study of the palaeontological literature, although stratigraphers have dutifully noted fish remains in many published sections. The following note, which describes a handful of specimens collected in a few minutes from a mere inch of the miles of section exposed, gives some hint of the scientific rewards which might be expected from a comprehensive study of Carboniferous ichthyology in the Canadian Maritime Provinces.

These specimens were found in steeply dipping beds of the upper Parrsboro formation (Riversdale group, Lower Pennsylvanian) on the west side of Parrsboro Inlet, south of the town of Parrsboro, Cumberland County, Nova Scotia. The source bed, a fissile carbonaceous shale rich in fresh-water pelecypods (colloquially termed a 'clam-coal'), crops out south of the mouth of Whitehall Creek and about 250 yards north of the small point which lies north of Pinky's Point. This collection was made in collaboration with William F. Take, geologist for the Nova Scotia Museum of Science, and Eldon George, proprietor of the Parrsboro Rock and Mineral Shop.

Class OSTEICHTHYES
Order PALAEONISCOIDEA
Family HAPLOLEPIDAE
Haplolepis (*Parahaplolepis*) aff. *anglica* (Traquair)

Material. A partial skull roof, Princeton University Geological Museum 17058. As the bone itself is slightly damaged, a high-fidelity latex cast made from its perfect impression on the counterpart slab was used for study. For technique see Baird (1955).

Description. To facilitate comparisons the conventional bone terminology is followed, although this usage implies no commitment on homologies with the skull bones of tetrapods.

The central area of the skull roof, all that is preserved in this specimen, forms an isosceles triangle bisected by the mid-sagittal suture; its anterior apex is rounded and its posterior side concave. Length along the midline is 6·2 mm. A transverse suture which passes diagonally forward and outward from the mid-sagittal suture divides the frontals

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from the dermopterotics. The frontals show an anterior margin which is irregularly rounded rather than angularly 'shouldered'; their lateral margins are slightly concave where they would adjoin the now-missing dermosphenotics. Just anterior to the mid-length of the frontals lies the pineal macula, a thinly ossified area 0·5 mm. in diameter, traversed by the interfrontal suture. A single pair of posterior elements, called dermopterotics by Westoll, correspond areally to the parietals and dermopterotics of more primitive haplolepids. Their posterior margins are embayed to receive the extrascapulars and posttemporals.

Clearly marked pit-line grooves occupy their customary positions. The anterior pit line crosses the transverse suture and, if extended, would connect the centres of ossification of the frontal and dermopterotic. The transversely aligned middle pit line and the short, diagonal posterior pit line are visible on the left but not the right dermopterotic. Variability in the expression of these lines is, of course, common among haplolepid fishes.

Surface sculpture is strongly developed. On each frontal it consists of tubercles and short rugae, with a conspicuous set of long rugae radiating posteromedially from the centre of ossification. On the dermopterotic the posterior two-thirds of the medial area is occupied by a series of long, sharp rugae extending from the centre of ossification to the mid-sagittal suture. The lateral area is covered with less pronounced, wavy rugae aligned more or less axially. Tiny tubercles cover the postero-lateral corner.

Relationships. Thanks to Westoll's splendid monograph (1944) on the Family Haplolepidae, the affinities of this fish are readily determined. Its broad skull roof and pineal macula indicate the genus *Haplolepis*; the posterior embayment, lack of parietals, and slightly oblique transverse suture place it in the subgenus *Parahaplolepis*. Within that subgenus comparisons must be made with *H. tuberculata* (Newberry) from the Upper Freeport coal of Linton, Ohio; *H. anglica* (Traquair) from the Ash coal of Longton, Staffordshire; and *H.* aff. *anglica* from the Low Main coal of Newsham, Northumberland. In outline and proportions—relative narrowness, rounded rather than shouldered anterior margin, and shallow rather than deep and angular posterior embayment—the Nova Scotia fish differs from *H. tuberculata* (compare text-figs. 1 and 3) but resembles *H. anglica* and (especially) *H.* aff. *anglica* from Newsham.

Comparisons of so variable a character as surface sculpture must be made cautiously when the Parrsboro, Longton, and Newsham populations of *Parahaplolepis* are each represented by a single usable specimen. As a check on variability I have analysed twenty-five skull roofs (nine photographs plus sixteen specimens at hand) of *H. tuberculata* from Linton, Ohio; these were preserved in a thin lentil of canneloid shale about an acre in extent, and may reasonably be presumed to represent a single breeding population. A subjective comparison of the more distinctive features is summarized in Table 1.

In surface features the Parrsboro skull roof shows none of the tendency toward reduction of sculpture and loss of the pineal macula which is seen in *H. tuberculata*. Its sculpture pattern differs from that of *H. anglica* proper but resembles that of *H.* aff. *anglica* so closely that their dissimilarities fall well within the range of individual variation. This concordance of characters in fishes from localities as widely separated (at least at present) as Northumberland and Nova Scotia suggests that these fishes represent a valid species

TABLE 1

Haplolepis (*Parahaplolepis*)—superficial features of skull roof

	Parrsboro specimen PU 17058	*H.* aff. *anglica* Hancock Museum (B)	*H. anglica*, Type BM[NH] P. 7995	*H. tuberculata* (per cent. of sample)	
					%
Pineal macula	clearly marked	clearly marked	faintly marked	clearly marked	37·5
				faint or absent	62·5
Intensity of sculpture	strong	fairly strong	strong	strong	16
				fairly strong	28
				weak	56
Sculpture on posteromedial area of frontal	long oblique rugae	short oblique rugae	longitudinal rugae	short oblique rugae	16·7
				longitudinal rugae	37·5
				irregular rugae or tubercles	45·8
Sculpture anterior to pineal macula	tubercles	tubercles	long oblique rugae	tubercles	37·5
				tubercles+irregular rugae	29·2
				short longitudinal rugae	33·3
Transverse rugae on dermopterotic	long, on posterior 2/3	long, on posterior 1/2	?few, short	none	28
				short	52
				long	20
				on posterior 1/2	39
				on posterior 1/3	55·5
				on posterior 1/4	5·5

distinct from *H. anglica*. Until the populations are better represented, however, a new specific name is hardly justified.

Stratigraphic distribution of Paraliaplolepis. The foregoing taxonomic placement, based on comparative morphology, is consistent with the relative geologic ages of the forms compared. While its level within the Parrsboro formation has not been determined with precision, the skull roof described here comes from the more carbonaceous upper part of the formation which corresponds to Floral Zone D of Dix's subdivision of the British Upper Carboniferous (Moore *et al.* 1944). The palaeobotanical evidence for this correlation (Bell 1944) is supported by the association of the Parrsboro *Paraliaplolepis* with *Anthraconaia* [*Anthracomya*] *modiolaris*, a fresh-water pelecypod which in England characterizes a zone equivalent to Floral Zone D (Trueman 1954, p. 73), and the mysidacean arthropod *Anthrapalaemon dubium* which also occurs in the lower and middle Westphalian A zone of Europe (Copeland 1957, p. 9).

The oldest haplolepid-bearing bed previously known is the cannel associated with the Low Main coal of Newsham, Northumberland, in which two specimens of *H.* aff. *anglica* were found. This coal seam lies at the base of the zone of *Anthracosia similis* and *Anthraconaia pulchra* (called the Similis–Pulchra Zone), corresponding to the base of Floral Zone E (Trueman 1954, pp. 73, 306). Younger still is the Ash (or Rowhurst) coal of Staffordshire, from the roof-shale of which came the type specimen of *H. anglica*. This seam lies above the middle of the Similis–Pulchra Zone, i.e. at about the base of Floral Zone F (ibid., pp. 73, 229). *Paraliaplolepis* is unreported from the rest of Zone F and Zone G. Correlative with lower Zone H is the Francis Creek shale of Mazon Creek, Illinois, in which a *tuberculata*-like species occurs. *H. tuberculata* proper is common in the basal cannel of the Upper Freeport coal which lies close to the boundary between Floral Zones H and I (Moore *et al.* 1944).

In terms of the continental European subdivision the stratigraphic distribution of *Haplolepis* (*Paraliaplolepis*) may be stated thus:

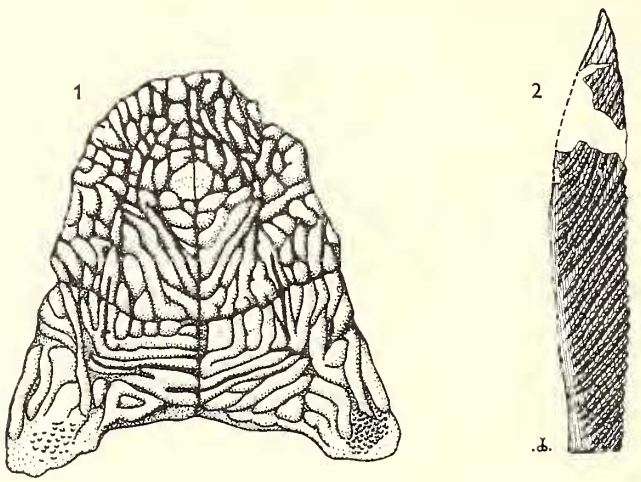
Late Westphalian D	*H. tuberculata* (Linton, Ohio)
Early Westphalian D	*H.* cf. *tuberculata* (Mazon Creek, Illinois)
Earliest Westphalian C	*H. anglica* (Longton, Staffordshire)
Late Westphalian B	*H.* aff. *anglica* (Newsham, Northumberland)
Middle Westphalian A	*H.* aff. *anglica* (Parrsboro, Nova Scotia)

The Parrsboro specimen is thus the oldest-known haplolepid fish as well as the first to be found in Canada.

Class ACANTHODII
Family GYRACANTHIDAE
Gyracanthus sp.

Material. A small fin-spine, PU 17059. This specimen is noteworthy in being the first unequivocal record of *Gyracanthus* in the Upper Carboniferous of North America. A small spine from the Joggins formation of the South Joggins, Cumberland County, Nova Scotia, was described by Dawson (1868, p. 210) as *Gyracanthus duplicatus*. Dawson's woodcut illustration is so generalized, however, that the generic assignment of his specimen has been questioned by Newberry (1889, p. 124). Until the type material of *G. duplicatus* at the Peter Redpath Museum in Montreal can be restudied, valid comparisons cannot be made; but the Parrsboro find makes plausible Dawson's identification of the Joggins specimen. As one comes from Floral Zone D and the other from Zone E, the stratigraphic interval between them is not large.

Description. The Parrsboro spine is nearly complete, lacking the proximal end and part of the point, and lies dorso-ventrally compressed in the shale. Its length as preserved is 58 mm. From an acute tip it widens to a maximum of 10·3 mm., forming a point 27 mm. long, then narrows gradually to a width of 7 mm. at the proximal fracture. Some thirty oblique ridges are preserved, spaced at about 1 mm. intervals, and sharply denticulated except toward the tip where pre-mortem abrasion has smoothed their crests. The more proximal of these ridges meet the anterior margin at an angle of about 40°; distally the



TEXT-FIG. 1. *Haplolepis* (*Parahaplolepis*) aff. *anglica* (Traquair), central area of skull roof, ×7·5. PU 17058. For orientation compare with text-fig. 3.
TEXT-FIG. 2. *Gyracanthus* spine, ×1. PU 17059. Camera obscura drawings.

ridges make a more acute angle, but irregularities and damage prevent an exact measurement. Posterior bifurcations and intercalations of the ridges occur at the widest part of the spine. The ridgeless posterior area of the spine (the part which was inserted in the soft tissues of the fin and body) is not restricted to the proximal end but extends past the zone of maximum width and onto the point. In this respect the Parrsboro spine resembles *Gyracanthus alleni* Newberry (1873; type specimen AMNH 403), found in the Lower Mississippian of Ohio. The similarity, however, is not necessarily of taxonomic significance and may mean only that the two spines occupied similar positions in the gyracanth armament.

Until all the nominal species of *Gyracanthus* have been systematically restudied—a chore beyond the scope of this paper—there is little point in assigning a specific name to the Parrsboro specimen. This find establishes beyond question the survival of *Gyracanthus* into early Pennsylvanian time in North America, and serves to emphasize the paradoxical rarity on this continent of a genus which is relatively common in the Pennsylvanian of Great Britain.

ASSOCIATED FAUNA

The source bed contains the following invertebrates, listed in order of decreasing

abundance: *Anthraconaia* [*Anthracomya*] *modiolaris*, ostracods, *Spirorbis*, *Anthrapalaemon dubium* (PU 84738), and a single specimen of *Palaeocaris* (PU 84739). On the latter specimen Murray J. Copeland of the Geological Survey of Canada reports as follows:

> 'The arthropod submitted is an anaspidacean apparently of the genus *Palaeocaris*. Unfortunately the specimen is relatively poorly preserved and does not permit specific identification. Its size might indicate it to be an immature specimen but this may also be a specific characteristic which might, if better preserved specimens were obtained, serve to further differentiate it from the Horton *P. novascoticus* and the Pictou *Palaeocaris sp.* To my knowledge this, together with a questionable specimen of *P. typus?* from your Locality B-13 . . . is the first known occurrence within rocks of the Riversdale group of specimens of this genus.'

[The *Palaeocaris* from MCZ Locality B-13, collected for Harvard in 1956, comes from a bituminous layer behind the breakwater cuesta of sandstone on the headland between Diligent and Ramshead Rivers, Cumberland County, Nova Scotia. This is Geological Survey of Canada Locality 25627, listed by Copeland (1957, p. 17).]

Dissociated fish remains include rhombic scales of the osteolepid crossopterygian *Megalichthys*; oval scales of a rhizodontid crossopterygian, apparently *Strepsodus dawsoni* Hay (PU 17150); and palaeoniscoid mandibles and a maxilla (PU 17149). The latter appear to fall within the range of variation of the genus *Elonichthys* and resemble, for example, those of *E. egertoni* from the Deep Mine ironstone shale of Longton, Staffordshire. Some years ago Eldon George collected from the same layer an articulated fish about 9 inches long, but the identity and whereabouts of this specimen are unknown.

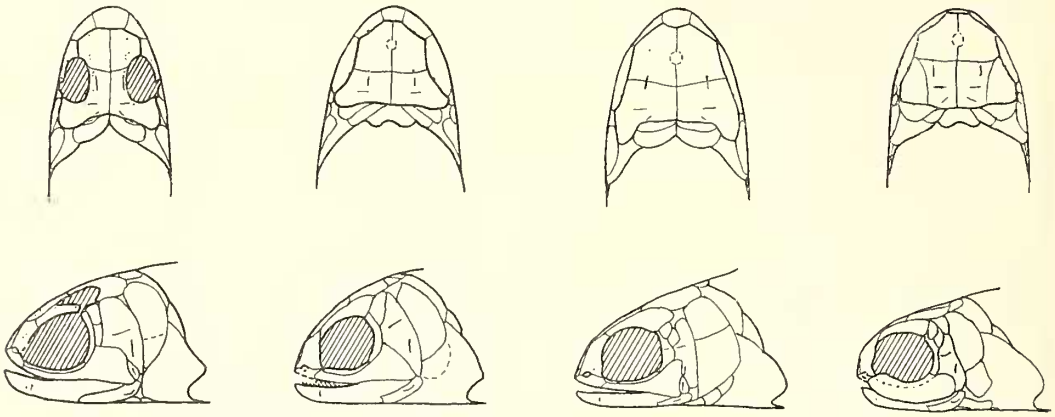
The known range of the Westphalian coal-swamp fauna which is characterized by haplolepid fishes has been extended several million years by the Parrsboro find. Since the first demonstration of this facies-fauna by Westoll in 1944, our knowledge of it has increased through new discoveries and extensive stratigraphic and taxonomic revisions, in large part unpublished. Lest the tail wag the dog, therefore, further discussion of the Parrsboro fauna is reserved for a future paper on the development of the haplolepid chronofauna.

NOTE ON HAPLOLEPID TYPE SPECIMENS FROM LINTON, OHIO

Westoll's (1944) monograph on the Haplolepidae cites specimens in the American Museum of Natural History as types or figured specimens of most of the nominal species described by J. S. Newberry. Specimen labels and comparisons with Newberry's figures justified these citations, especially as the specimens had come from Newberry's collection at the Columbia College School of Mines. But Newberry, either when director of the Geological Survey of Ohio or later when a professor at Columbia, had sent suites of Linton fossils to several institutions; and several specimens labelled 'Type' were so distributed. The Geological Survey collection at Ohio State University includes five haplolepids labelled as holotypes of Newberry's species: *Eurylepis corrugatus* (OSU 4478), *E. insculptus* (OSU 4514), *E. lineatus* (OSU 4565), *E. ovoideus* (OSU 4563), and *E. striolatus* (OSU 4508). These are cited as types in Morningstar's (1924) catalogue, a publication which Westoll overlooked.

One example of confusion in the identification of type specimens is the case of *Eurylepis insculptus* Newberry, a nominal species which Westoll has quite validly reduced to synonymy with *Haplolepis tuberculata*. At least three individual fishes—OSU 4514, AMNH 448-G, and PU 1767—bear labels inscribed in Newberry's hand: 'Eurylepis

insculptus N. Type.' None of them is the specimen figured under that name by Newberry (1873, pl. 39, fig. 2). Although Westoll (1944, p. 32) cites AMNH 448-G as the type of *E. insculptus*, Morningstar's designation of OSU 4514 takes precedence. No problem of taxonomy arises in this case of multiple 'types', since the three specimens (which I have examined) all represent *Haplolepis tuberculata*.



Pyritocephalus lineatus *H. (H.) corrugata* *H. (P.) tuberculata* *H. (H.) ovoidea*

TEXT-FIG. 3. Restored skulls of Haplolepidae from Linton, Ohio, drawn to common scale (from Westoll).

The possibility of rival type specimens for Newberry's other species should not be overlooked. In some cases the explanation may be that part and counterpart slabs of a skeleton may be housed in two museums. In this fashion, for example, Princeton and the American Museum share Newberry's type specimen of the Linton amphibian *Ctenerpeton remex* (Cope). In cases where the rival specimens are not counterparts, type designations by Morningstar (1924) must be accepted unless there is evidence to the contrary.

The following brief key and diagrams (text-fig. 3) will facilitate the identification of haplolepids from Linton:

A. Anterior lateral line scales with smooth posterior margin	*Pyritocephalus*
B. Anterior lateral line scales with serrate posterior margin	*Haplolepis*
1. Lateral line scale width = $\frac{1}{3}$ scale height	*corrugata* [rare]
2. Lateral line scale width = $\frac{1}{4}$ scale height	*tuberculata* *ovoidea*
a. Body long, dorsal fin opposite anal	*tuberculata*
b. Body short, dorsal fin anterior to anal	*ovoidea*

The material described above was collected in the course of exploration sponsored jointly by the Nova Scotia Museum of Science and Princeton University, an extension of previous exploration by parties from the Museum of Comparative Zoology at Harvard College under the direction of Alfred S. Romer. Special thanks are due to my colleagues at the Nova Scotia Museum of Science, Curator of Geology William F. Take and Director D. K. Crowdis. We are particularly indebted to Eldon George, proprietor of the Parrsboro Rock and Mineral Shop, on whose property and with whose help the collection was made. Identifications of the invertebrates were made by Murray J. Copeland of the

Geological Survey of Canada, whose familiarity with Acadian Carboniferous stratigraphy has greatly aided our research. I am especially grateful to Bobb Schaeffer for access to comparative collections at the American Museum of Natural History and for his critical reading of the manuscript. Mildred F. Marple, John J. Stephens, and J. E. Carman hospitably made available the collections at Ohio State University. Frank N. Goto prepared the *Gyracanthus* spine. Field work was financed in 1956 by a National Science Foundation grant to Harvard, and in 1959 by the William Berryman Scott Research Fund of Princeton University.

ADDENDUM: *HAPLOLEPIS* IN THE JOGGINS FORMATION

While this paper was in press a second Nova Scotian specimen of *Haplolepis* was identified. This fish, Museum of Comparative Zoology, No. 8867, was collected in 1956 by Murray J. Copeland and the author. Its source is the calcareous, carbonaceous shale roof of the Forty Brine coal seam which crops out in the sea-cliff north of the wharf at Joggins, Cumberland County. This horizon lies about 340 feet below that of the famous, amphibian-bearing upright trees; both are included in the Joggins formation of the Cumberland group and are dated as early Westphalian B. According to Copeland (letter, 1961) the Forty Brine seam is presumably the same as coal group 24 of Logan's stratigraphic section; the amphibian-bearing trees occur between coal groups 14 and 15 which unite farther to the east to form the Kimberly seam.

The fish, unfortunately headless, is somewhat macerated and compressed so that the fins cannot be made out; the calcareous matrix does not permit the fractured bones and scales to be removed by etching. Such diagnostic parts as are visible—the cleithra and the antero-lateral scales—appear nearly identical to those of *Haplolepis* (*H.*) *corrugata* (Newberry) from Linton, Ohio, as illustrated by Westoll (1944, figs. 10*b*, 11*a*). Until better material is available this fish may be designated *Haplolepis* cf. *corrugata*.

If correctly identified, the Joggins specimen represents the earliest known appearance of the subgenus *Haplolepis*. The oldest previous record was that of *H.* (*H.*) *attheyi* Westoll from the Low Main seam of Newsham, Northumberland, which is late Westphalian B in age.

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